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January 22, 1996

Mr. Kevin Rochlin
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, HW-113
Seattle, Washington 98101

Re: Evaluation of Need for Leachate Collection System
Spokane Junkyard and Associated Properties Superfund Site

Dear Mr. Rochlin:

This memorandum regarding the applicability of a leachate collection system at the Spokane Junkyard and Associated Properties Superfund Site (Site) is submitted on behalf of Kaiser Aluminum & Chemical Corporation, The Washington Water Power Company, and Inland Power. This is sent to you in accordance with your request for additional information regarding the "Combination Alternative" as described in Section 7 of the Engineering Evaluation/Cost Analysis (EE/CA) submitted in December, 1995.

BACKGROUND

The "Combination Alternative" included the following features:

1. All soils containing greater than 400 mg/kg lead and/or greater than 1 mg/kg PCBs would be excavated from the entire Site and consolidated onto the Spokane Metals Company property.

2. Soils containing greater than 5,000 mg/kg lead would be solidified so as to prevent accidental excavation and stabilized so as to pass the Toxicity Characteristic Leaching Procedure (TCLP) test for lead.

3. All contaminated soils described in 1 and 2 above would be placed under a geomembrane cap and covered with several feet of soil.

As described in the EE/CA, the envisioned alternative does not include a bottom liner or leachate collection system. This is appropriate for the following reasons:

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- The presence of the geomembrane cap over the solidified/consolidated soil.

- The reduction in permeability of the solidified soil which will be placed immediately below the geomembrane cap and therefore further reduces the potential for downward water migration.

- The fact that the soils to be placed beneath the cap will have only sufficient water in them at the time of placement to allow proper compaction.

- No putrescible, compressible, or other liquid bearing materials will be placed in the soil cell.

- Meteorological conditions in the Spokane are, which feature low precipitation (16 to 17 inches per year) and generally arid conditions which contribute to high rates of evapotranspiration in the area, as described in Section 2.7 of the EE/CA.

- The low solubility and mobility of the principle chemicals of concern in the soils (Lead and PCBs).

Precipitation and temperature information for the area was presented in the EE/CA on Tables 2-2 and 2-3, respectively. These tables are attached to this memorandum as Tables 1 and 2. These tables show that approximately 30 percent of the precipitation occurs during the summer months (May through September) when temperatures are highest and evaporation can be expected to be substantial. Even during cooler months, evaporation can be high due to low humidity commonly occurring.

EVALUATION

In order to quantitatively evaluate the need for a bottom liner/leachate collection system, this evaluation utilized a computer modeling and engineering analysis of the model output approach. The computer model utilized was the Hydraulic Evaluation of Landfill Performance (HELP) which was developed by the U.S. Army Corps of Engineers and which has been adopted by EPA (Schroeder, P. R., Dozier, T.S., Zappi, P. A., McEnroe, B. M., Sjostrom, J. W., and Peyton, R. L.; 1994; *The Hydrologic Evaluation of Landfill Performance (HELP) Model;* EPA/600/R-94/168b, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.). Our modeling used version 3.04, dated March 15, 1995.

This evaluation included the following:

- Review of conceptual design, potential soil quantities to be placed in the cell during the Removal Action Construction, and different material layers involved.
- Preparation of the necessary input files for the computer program HELP.
- Performance of five model simulations, using variations in the function and engineering properties of the fill layers.
- Analysis of model results.

The abstract of the HELP User's Guide contains the following description of the program:

> *The Hydrologic Evaluation of Landfill Performance (HELP) computer program is a quasi-two-dimensional hydrologic model of water movement across, into, through and out of landfills. The model accepts weather, soil and design data and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane or composite liners. Landfill systems including various combinations of vegetation, cover soils, waste cells, lateral drain layers, low permeability barrier soils, and synthetic geomembrane liners may be modeled. The program was developed to conduct water balance analyses of landfills, cover systems, and solid waste disposal and containment facilities. As such, the model facilitates rapid estimation of the amounts of runoff, evapotranspiration, drainage, leachate collection, and liner leakage that may be expected to result from the operation of a wide variety of landfill designs. The primary purpose of the model is to assist in the comparison of design alternatives as judged by their water balances. The model, applicable to open, partially closed, and fully closed sites, is a tool for both designers and permit writers.*

CONCEPTUAL DESIGN

The conceptual design of the soil cell is described in the Conceptual Design Memorandum by ALTA Geosciences dated January 10, 1996. The following figures from the Conceptual Design Memorandum are attached to this Evaluation of Need for Leachate Collection System:

Figure 1 - Site Plan

Figure 2 - Typical Section
Figure 3 - Cell Profile

METEOROLOGICAL PARAMETERS

The program uses a combination of historical and synthetically generated data based on coefficients for Spokane, Washington. Precipitation, average annual wind speed, and mean monthly temperature values used by the program correspond well with the values presented in the EE/CA report. The values used by the program are presented in the attached printout of a typical output file, and are comparable to the data presented in the EE/CA and shown on Tables 1 and 2.

ASSUMED SOIL PROFILE

Figure 4 presents the assumed soil profile used in the model. Soil layer thicknesses may not match exactly those shown in the Conceptual Design Memorandum (and on Figure 3) as this Evaluation of Need for Leachate Collection System was begun before the conceptual design was completed. Such minor variations have no significant impact on the results of this analysis. The layers in this model are as follows:

LAYER NUMBER	LAYER DESCRIPTION
1	Topsoil, sandy silt, uncompacted, excavated on site or imported
2	Clean sand & gravel, lateral drainage
3	Clean sand, protects geomembrane, lateral drainage
4	Geomembrane, 40-mil HDPE
5	Clean sand, protects geomembrane
6	Soil cement, stabilized impacted site soils, compacted
7	Sand & gravel, consolidated impacted site soils, compacted
8	Clean sand, protects geomembrane, lateral drainage, contains leachate collection piping network
9	Geomembrane, 40-mil HDPE
10	Clean sand, protects geomembrane
11	Native Soil, undisturbed

Layers 8 through 10 represent a hypothetical leachate collection system which is not included in the present conceptual design. This is included in the model to allow the model to calculate the amount of leachate that would accumulate if such a system were installed.

Layers 2 and 3 can be treated as simply vertical percolation layers or as lateral drainage layers. The difference in the model output is significant for lower layers (see discussion of results).

Layers 4 and 9 are HDPE geomembranes. Experience has shown that most geomembranes leak to some extent, most likely through pinholes, defective seams, or sometimes because of poor construction techniques. Therefore, the HELP program accounts for potential leakage by allowing the user to select the number of pinholes, defective seams, and construction quality. Guidance is provided in the program documentation regarding the range of values that have been presented in the literature. The model was run using a typical number of pinholes and seam defects, with fair construction quality. It was also run with an exceptionally high number of pinholes and seam defects, with poor construction quality. There was no significant difference in the results as far as the amount of leakage through the liner or efficiency of the leachate collection system. The assumption that geomembranes at the Spokane Junkyard Site would leak as much as the model suggests is conservative, but not necessarily true. With good construction quality control, the potential leakage could be much less.

Layer 8 is assumed to contain a leachate collection piping network, which would typically consist of slotted 4-inch HDPE pipe. Layer 8 is assumed to be a lateral drainage layer with adequate piping to carry all lateral drainage to a discharge point.

RESULTS OF EVALUATION

Although the evaluation looked at several parameter variations, only two will be discussed here.

Case One -- No Lateral Drainage Near Surface

Using average annual values for ten years of simulation, precipitation totals 16.8 inches, surface runoff totals 3.5 inches, evapotranspiration totals 10.6, and infiltration reaching the first barrier layer is 2.7 inches. Layers 2 and 3 are considered vertical percolation layers only, and do not allow lateral drainage to the outside. Therefore, the top geomembrane (Layer 4) receives the entire 2.7 inches of water per year. Because of seam defects and pinholes in the geomembrane, this amount also penetrates the geomembrane. Intervening Layers 5 - 8 do not significantly slow down the vertical migration of this water and it reaches the bottom geomembrane (Layer 9). As soon as it builds up enough to flow laterally, it enters the leachate piping and is discharged from the fill. The amount being discharged is 2.43 inches per year (the difference between this and 2.7 goes into storage). Leakage Through the bottom geomembrane averages 0.002 inches per year or 9.5

cubic feet per acre, per year. If the piping were plugged and Layer 8 did not allow lateral drainage, the full 2.43 inches per year would leak out the bottom of the system through liner defects. The model calculates this quantity to be about 8700 cubic feet per acre, per year.

Case Two -- Lateral Drainage Near Surface

A major difference with this case compared to Case One is that Layers 2 and 3 are allowed to drain laterally. Layer 8, overlying the bottom geomembrane is still a lateral drainage layer (with collection piping). The average annual near-surface water totals are the same; 16.8 inches precipitation, 3.5 inches runoff, and 10.6 inches evapotranspiration. However, now 2.7 inches is discharged from layer 3. A minor amount still leaks through, about 0.002 inches per year. Over time, this amount would also reach Layer 8 and the bottom geomembrane (Layer 9). However, because of its small quantity (approximately 9.5 cubic feet per acre, per year), the water never builds up enough on the geomembrane to enter the piping and flow out of Layer 8, instead, it slowly leaks through the defects in the geomembrane and is lost out the bottom. The quality of this potential or modeled water is unknown, however considering the limited solubility of lead in rainwater/snowmelt and the fact that the most highly contaminated soils will be solidified/stabilized to further reduce the potential for Lead in the soils to mobilize, it is unlikely that this water will contain appreciable concentrations of Lead.

DISCUSSION

Consideration of these two cases shows that the lateral drainage in Layers 2 and 3 is critical to preventing water from entering the zones of impacted soil beneath the top geomembrane. With such lateral drainage, almost nothing leaks through the top geomembrane. If Layers 2 and 3 allow lateral drainage, the amount of water reaching Layer 8 is so small that it would not build up on top of Layer 9 enough to flow out the piping, thus making the piping and lower geomembrane of no benefit.

According to the Conceptual Design Memorandum, Layer 2 will consist of clean sand and gravel from excavation of the soil cell. Review of the Site Evaluation Report (ALTA Geosciences, August 1995) shows that Site soils from greater than 3 feet deep are "Sandy gravel or gravelly sand, less than 5 percent silt, gravel 30-60 percent". Such soil material should make for excellent lateral drainage.

Additionally, the long-term functioning of buried leachate piping systems is problematic. They have to be designed for cleaning and maintenance which results in additional O&M costs. If the piping fails, due to clogging or some other reason, the situation is worse, because the bottom geomembrane acts like a bathtub,

possibly creating a saturated zone in the layer of impacted soil. In such a case, it would be better to have no lower liner at all.

The best engineering choice is to prevent contact of water with the impacted soils. This would be accomplished by having an effective drainage layer (Layers 2 and 3) overlying a properly constructed upper geomembrane (Layer 4). If these two design features are implemented as described in the Conceptual Design Memorandum, an underlying leachate collection piping and geomembrane system provides no additional benefits. Onsite soils from greater than 3 feet depth should provide adequate drainage capability. The upper geomembrane (Layer 4) should be sloped to prevent water from ponding.

Potential future construction on top of the soil cell would not adversely affect the lateral drainage estimates described above. In fact, paved parking with suitably designed stormwater runoff provisions, or buildings with roof drains directed to storm drains, would further reduce the amount of water entering subsurface soils.

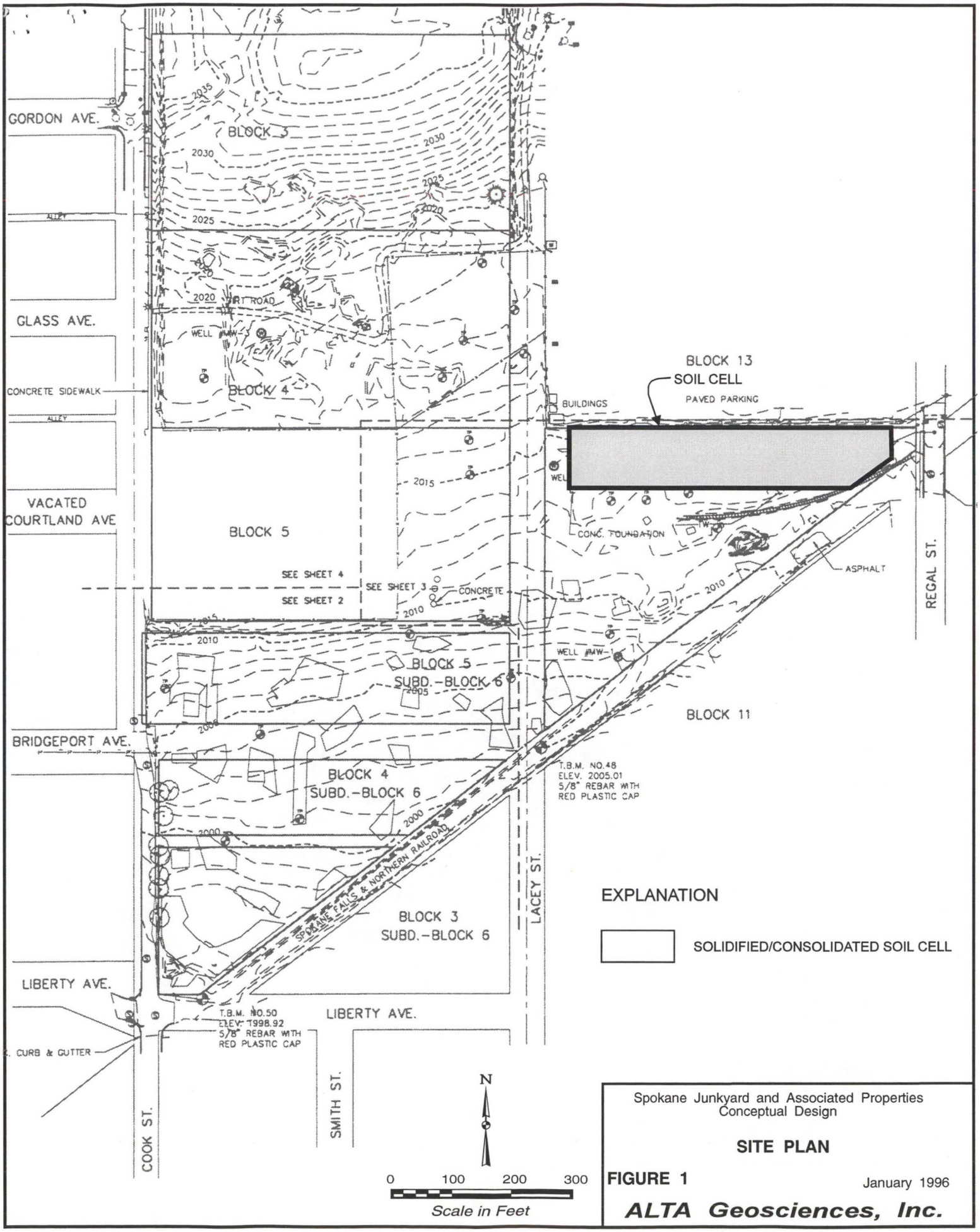
If you have any questions, please feel free to contact me at your earliest convenience.

Sincerely,
***ALTA* Geosciences, Inc.**

Alex Tula, R.G.
Principal Consultant

enclosure: Tables 1, 2
Figures 1 through 4
Computer run input/output printouts

cc: Mr. Bud Preston; Kaiser Aluminum & Chemical Corporation
Mr. Doug Pottratz; The Washington Water Power Company
Mr. Grant Van Buren; Inland Power
R. Paul Beveridge, Esq.; Heller, Ehrman, White, & McAuliffe
Mark Hausman, Esq.; Paine, Hamblen, Coffin, Brooke & Miller
David A. Kulisch, Esq.; Randall & Danskin, PS



Spokane Junkyard and Associated Properties
Conceptual Design

SITE PLAN

FIGURE 1

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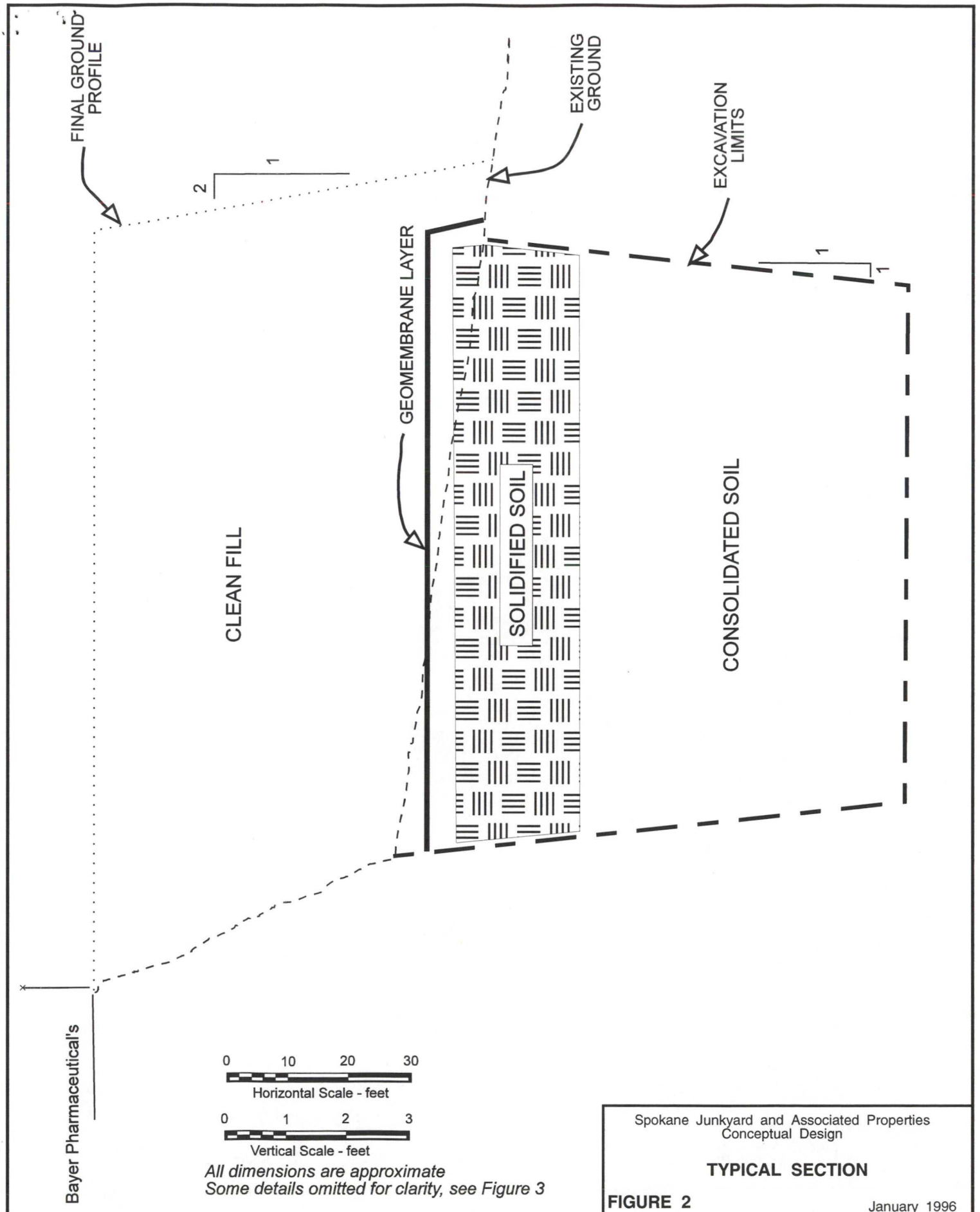
E95-1016



All dimensions are approximate
Some details omitted for clarity, see Figure 3

Spokane Junkyard and Associated Properties
Conceptual Design

TYPICAL SECTION

FIGURE 2

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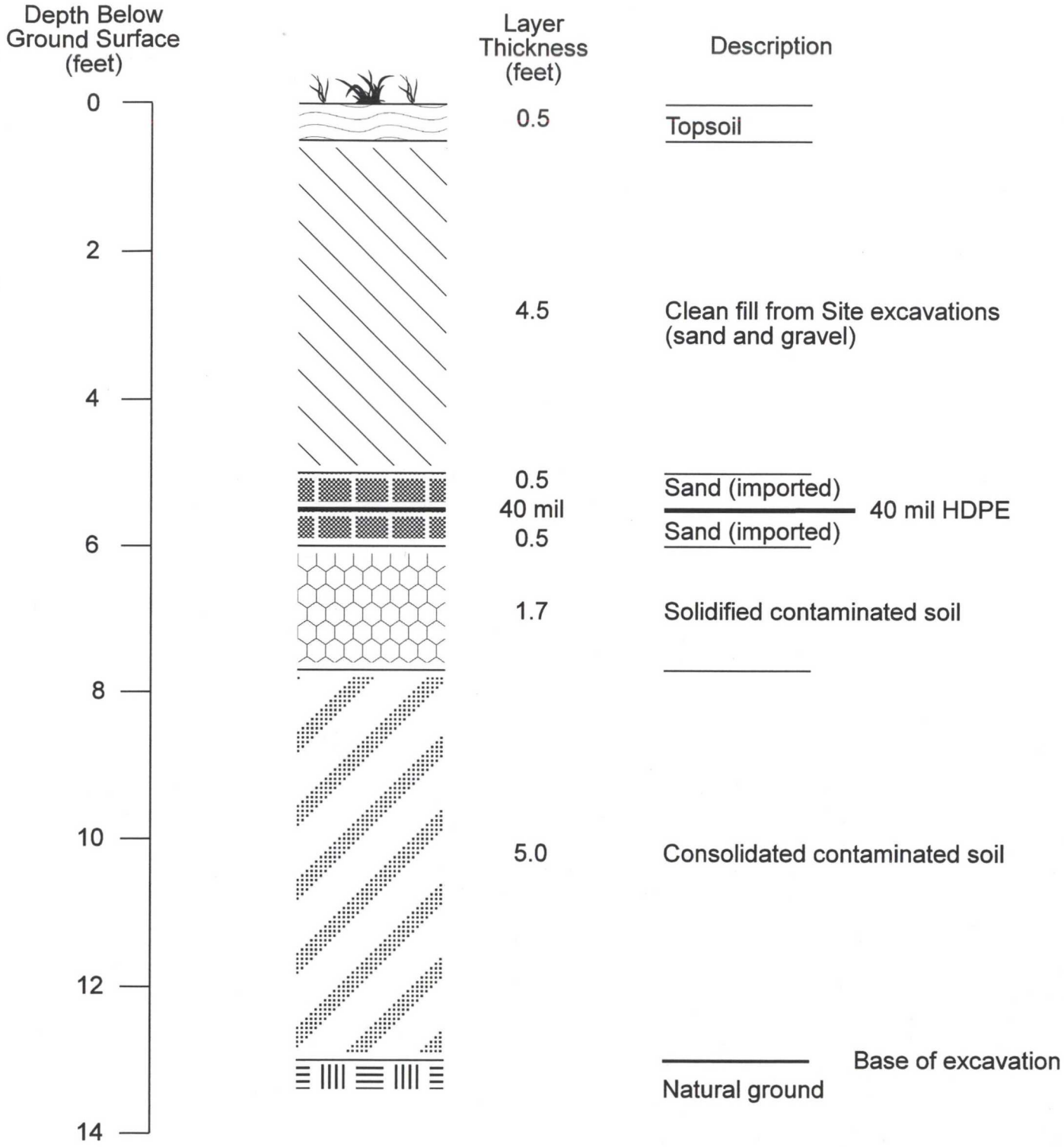

Spokane Junkyard and Associated Properties
Conceptual Design

CELL PROFILE

FIGURE 3

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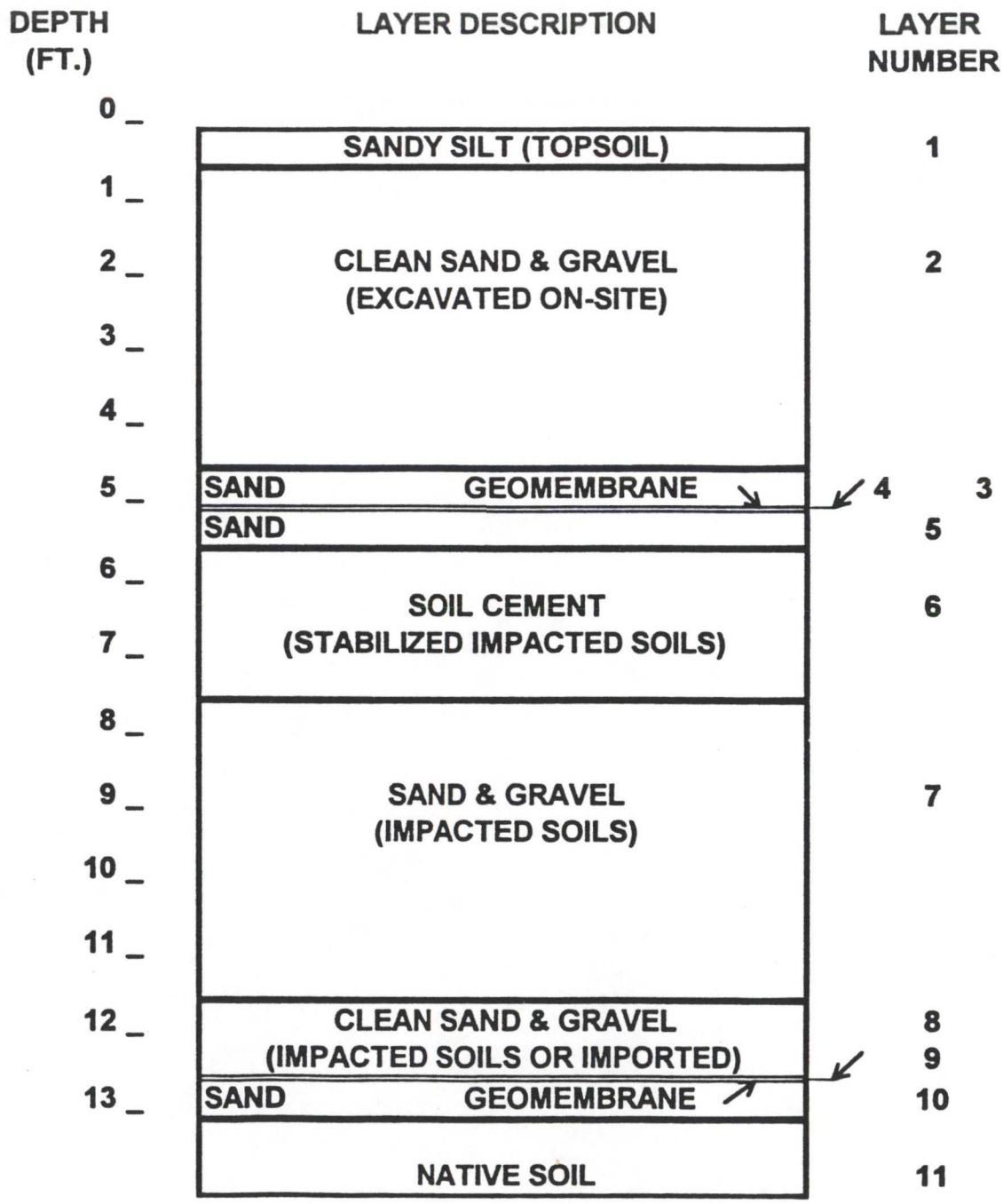

Spokane Junkyard and Associated Properties
Evaluation of Need for Leachate Collection System

SOIL PROFILE FOR HELP MODELLING

FIGURE 4 January 1996

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)         **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY            **
**                   USAE WATERWAYS EXPERIMENT STATION              **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     D:\HELP3\DATA4.D4
TEMPERATURE DATA FILE:       D:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:   D:\HELP3\DATA13.D13
EVAPOTRANSPIRATION DATA:     D:\HELP3\DATA11.D11
SOIL AND DESIGN DATA FILE:   D:\HELP3\DATA10.D10
OUTPUT DATA FILE:            D:\HELP3\SPOKE001.OUT


TIME:  12:58     DATE:   1/ 9/1996


**********************************************************************

     TITLE:  SPOKANE JUNKYARD SUPERFUND SITE -- REMEDIAL CONSTRUCTION

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   8
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4630 VOL/VOL
          FIELD CAPACITY                =      0.2320 VOL/VOL
          WILTING POINT                 =      0.1160 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.4328 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     = 0.369999994000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  2.49
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	48.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0927	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0451	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	0.00	PERCENT
DRAINAGE LENGTH	=	0.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL

INITIAL SOIL WATER CONTENT	=	0.0450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.3650	VOL/VOL
FIELD CAPACITY	=	0.3050	VOL/VOL
WILTING POINT	=	0.2020	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3650	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.500000024000E-03	CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 3

THICKNESS	=	48.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0830	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.310000009000E-02	CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	0.00	PERCENT
DRAINAGE LENGTH	=	0.0	FEET

LAYER 9

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL

FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	4 - POOR

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0442 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 13.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER	=	81.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	32.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.617	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	14.140	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.320	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	21.136	INCHES
TOTAL INITIAL WATER	=	21.136	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM SPOKANE WASHINGTON

STATION LATITUDE	=	47.62 DEGREES
MAXIMUM LEAF AREA INDEX	=	1.60
START OF GROWING SEASON (JULIAN DATE)	=	130
END OF GROWING SEASON (JULIAN DATE)	=	275

EVAPORATIVE ZONE DEPTH	=	32.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	58.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	48.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	78.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.47	1.61	1.36	1.08	1.38	1.23
0.50	0.74	0.71	1.08	2.06	2.49

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.70	32.40	37.60	45.80	54.30	61.70
69.70	68.10	59.40	47.60	34.90	29.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON
AND STATION LATITUDE = 47.62 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.20	58806.008	100.00
RUNOFF	3.409	12375.900	21.05
EVAPOTRANSPIRATION	10.410	37786.738	64.26
DRAINAGE COLLECTED FROM LAYER 3	2.3219	8428.374	14.33
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0021		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.004205	15.264	0.03
CHANGE IN WATER STORAGE	0.055	199.720	0.34
SOIL WATER AT START OF YEAR	21.946	79663.273	
SOIL WATER AT END OF YEAR	22.001	79862.992	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.013	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.31	66465.305	100.00
RUNOFF	4.017	14581.555	21.94
EVAPOTRANSPIRATION	12.133	44043.121	66.26
DRAINAGE COLLECTED FROM LAYER 3	3.1356	11382.223	17.13
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0028		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.003619	13.138	0.02
CHANGE IN WATER STORAGE	-1.000	-3630.582	-5.46
SOIL WATER AT START OF YEAR	22.001	79862.992	

SOIL WATER AT END OF YEAR	21.001	76232.406	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0209	75.850	0.11

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.47	59786.125	100.00
RUNOFF	3.907	14182.434	23.72
EVAPOTRANSPIRATION	8.428	30592.492	51.17
DRAINAGE COLLECTED FROM LAYER 3	3.2928	11952.913	19.99
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0030		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.003169	11.503	0.02
CHANGE IN WATER STORAGE	0.816	2962.021	4.95
SOIL WATER AT START OF YEAR	21.001	76232.406	
SOIL WATER AT END OF YEAR	20.843	75661.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.973	3533.384	5.91
ANNUAL WATER BUDGET BALANCE	0.0234	84.762	0.14

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.30	59169.004	100.00
RUNOFF	2.227	8085.562	13.67
EVAPOTRANSPIRATION	11.974	43464.777	73.46
DRAINAGE COLLECTED FROM LAYER 3	2.5583	9286.692	15.70
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0023		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.002820	10.236	0.02
CHANGE IN WATER STORAGE	-0.462	-1678.296	-2.84
SOIL WATER AT START OF YEAR	20.843	75661.047	
SOIL WATER AT END OF YEAR	20.789	75464.266	
SNOW WATER AT START OF YEAR	0.973	3533.384	5.97
SNOW WATER AT END OF YEAR	0.565	2051.866	3.47
ANNUAL WATER BUDGET BALANCE	0.0000	0.030	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.13	58551.902	100.00
RUNOFF	2.738	9938.740	16.97
EVAPOTRANSPIRATION	10.835	39331.914	67.17

DRAINAGE COLLECTED FROM LAYER 3	2.0013	7264.653	12.41
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0018		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.002523	9.160	0.02
CHANGE IN WATER STORAGE	0.553	2007.416	3.43
SOIL WATER AT START OF YEAR	20.789	75464.266	
SOIL WATER AT END OF YEAR	21.907	79523.555	
SNOW WATER AT START OF YEAR	0.565	2051.866	3.50
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.23	62544.914	100.00
RUNOFF	3.385	12285.907	19.64
EVAPOTRANSPIRATION	9.738	35347.906	56.52
DRAINAGE COLLECTED FROM LAYER 3	3.7460	13597.839	21.74
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0034		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.002285	8.296	0.01
CHANGE IN WATER STORAGE	0.348	1263.901	2.02
SOIL WATER AT START OF YEAR	21.907	79523.555	
SOIL WATER AT END OF YEAR	21.752	78958.023	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.504	1829.426	2.92
ANNUAL WATER BUDGET BALANCE	0.0113	41.064	0.07

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.74	57136.215	100.00
RUNOFF	3.394	12321.688	21.57
EVAPOTRANSPIRATION	9.909	35970.223	62.96
DRAINAGE COLLECTED FROM LAYER 3	3.2054	11635.544	20.36
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0029		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.002086	7.572	0.01
CHANGE IN WATER STORAGE	-0.771	-2798.810	-4.90
SOIL WATER AT START OF YEAR	21.752	78958.023	
SOIL WATER AT END OF YEAR	20.963	76094.992	
SNOW WATER AT START OF YEAR	0.504	1829.426	3.20

SNOW WATER AT END OF YEAR	0.522	1893.646	3.31
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.90	68607.016	100.00
RUNOFF	3.832	13909.110	20.27
EVAPOTRANSPIRATION	11.854	43029.094	62.72
DRAINAGE COLLECTED FROM LAYER 3	3.5202	12778.369	18.63
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0032		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.001922	6.976	0.01
CHANGE IN WATER STORAGE	-0.308	-1116.572	-1.63
SOIL WATER AT START OF YEAR	20.963	76094.992	
SOIL WATER AT END OF YEAR	21.166	76831.445	
SNOW WATER AT START OF YEAR	0.522	1893.646	2.76
SNOW WATER AT END OF YEAR	0.011	40.624	0.06
ANNUAL WATER BUDGET BALANCE	0.0000	0.036	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.18	58733.406	100.00
RUNOFF	3.515	12759.167	21.72
EVAPOTRANSPIRATION	10.522	38194.480	65.03
DRAINAGE COLLECTED FROM LAYER 3	2.0119	7303.241	12.43
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0018		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.001771	6.428	0.01
CHANGE IN WATER STORAGE	0.119	432.030	0.74
SOIL WATER AT START OF YEAR	21.166	76831.445	
SOIL WATER AT END OF YEAR	20.446	74217.656	
SNOW WATER AT START OF YEAR	0.011	40.624	0.07
SNOW WATER AT END OF YEAR	0.850	3086.445	5.26
ANNUAL WATER BUDGET BALANCE	0.0105	38.061	0.06

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.18	62363.406	100.00
RUNOFF	4.728	17161.428	27.52
EVAPOTRANSPIRATION	10.552	38305.508	61.42
DRAINAGE COLLECTED FROM LAYER 3	1.3665	4960.562	7.95
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0012		

PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 10	0.001645	5.970	0.01
CHANGE IN WATER STORAGE	0.530	1922.654	3.08
SOIL WATER AT START OF YEAR	20.446	74217.656	
SOIL WATER AT END OF YEAR	21.826	79226.750	
SNOW WATER AT START OF YEAR	0.850	3086.445	4.95
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0020	7.286	0.01

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.57	1.69	1.41	0.96	1.50	1.01
	0.48	0.97	0.75	0.88	2.09	2.54
STD. DEVIATIONS	0.86	0.57	0.72	0.56	1.30	0.77
	0.48	0.72	0.45	0.45	0.64	0.91
RUNOFF						
TOTALS	1.222	1.168	0.384	0.012	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.729
STD. DEVIATIONS	1.002	0.865	0.481	0.032	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.680
EVAPOTRANSPIRATION						
TOTALS	0.374	0.264	0.717	1.816	1.404	1.540
	1.290	0.785	0.880	0.609	0.543	0.414

STD. DEVIATIONS	0.081	0.064	0.362	0.394	0.766	0.752
	0.400	0.439	0.530	0.316	0.087	0.069

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.1734	0.1029	0.1097	0.5790	0.4491	0.2928
	0.3108	0.2571	0.1414	0.1117	0.0817	0.1066
STD. DEVIATIONS	0.1122	0.0354	0.0979	0.3830	0.2056	0.0867
	0.0570	0.0403	0.0231	0.0120	0.0083	0.0736

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0019	0.0012	0.0012	0.0064	0.0048	0.0032

	0.0033	0.0027	0.0016	0.0012	0.0009	0.0012
STD. DEVIATIONS	0.0012	0.0004	0.0011	0.0043	0.0022	0.0010
	0.0006	0.0004	0.0003	0.0001	0.0001	0.0008

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	16.86	(1.036)	61216.3	100.00
RUNOFF	3.515	(0.6897)	12760.15	20.844
EVAPOTRANSPIRATION	10.635	(1.1468)	38606.62	63.066
LATERAL DRAINAGE COLLECTED FROM LAYER 3	2.71599	(0.77915)	9859.041	16.10525
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.002	(0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	(0.000)		

PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00260	(0.00084)	9.454	0.01544
CHANGE IN WATER STORAGE	-0.012	(0.6048)	-43.65	-0.071

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	1.21	4392.300
RUNOFF	1.732	6286.5996
DRAINAGE COLLECTED FROM LAYER 3	0.09380	340.47794
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.032	
MAXIMUM HEAD ON TOP OF LAYER 4	0.000	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	
DRAINAGE COLLECTED FROM LAYER 8	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	?????????	
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000012	0.04532
SNOW WATER	2.86	10395.9307

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2085

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0413

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	2.1420	0.3570
2	4.8100	0.1002
3	0.2706	0.0451
4	0.0000	0.0000
5	0.2700	0.0450
6	8.7600	0.3650
7	3.9840	0.0830
8	0.5400	0.0450
9	0.0000	0.0000
10	0.2390	0.0398
SNOW WATER	0.000	

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